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# Request for grant of a patent

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The Patent Office

Cardiff Road
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NP10 8QQ

1. Your reference — RFW/ND/CB60691P

2. Patent application number *(The Patent Office will fill this part in)* — 22 JAN 2004 — 0401382.7

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

GLAXO GROUP LIMITED
GLAXO WELLCOME HOUSE
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00473587003
Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation — GB

4. Title of the invention — Toothbrush

5. Name of your agent *(if you have one)* — Corporate Intellectual Property

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

GLAXOSMITHKLINE
CORPORATE INTELLECTUAL PROPERTY (CN9 25.1)
980 GREAT WEST ROAD
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TW8 9GS

Patents ADP number *(if you know it)* 08072555004

6. Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.

| Country | Priority application number *(if you know it)* | Date of filing *(day / month / year)* |
|---|---|---|

7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute (see note f)

| Number of earlier UK application | Date of filing *(day / month / year)* |
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8. Is a Patents Form 7/77 (Statement of inventorship and of right to grant of a patent) required in support of this request?
Answer YES if:
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
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9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

| | |
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| Continuation sheets of this form | |
| Description | 12 |
| Claim(s) | 3 |
| Abstract | |
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| Priority documents | |
| Translations of priority documents | |
| Statement of inventorship and right to grant of a patent (Patents Form 7/77) | |
| Request for a preliminary examination and search (Patents Form 9/77) | |
| Request for a substantive examination (Patents Form 10/77) | |
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11. I/We request the grant of a patent on the basis of this application.

Signature(s) R. F. Walker

Date 22 January 2004

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom

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## Toothbrush.

This invention relates to toothbrushes, in particular to electrically powered toothbrushes.

Electrically powered toothbrushes are well known articles. They generally comprise a head which supports a bristle carrier from which bristles (the term "bristle" as used herein encompasses other dental cleaning elements such as plastics material or elastomeric flaps, strips, fingers or lamellae) extend in a bristle direction, the head being connected to (or connectable to in a replaceable head toothbrush) a grip handle. The bristle carrier is moveable to move the bristles in a tooth-cleaning effect, e.g. in a rotary, oscillatory rotary, reciprocal, vibratory, combinations thereof or other direction, and can be driven in this movement by a small electric motor. The motor is generally located in the grip handle and connected to the bristle carrier by a suitable gearbox, transmission or drive train, but electric toothbrushes are known in which the motor is located in the head or in a neck between the head and handle. Motors are well known which can produce rotary, oscillatory rotary, reciprocal, vibratory, combinations thereof or other types of motion.

Such a motor needs an electric power supply and this is normally also located in the handle. Additionally the handle normally includes suitable controls such as an on-off switch, speed control etc. At present there are two main types of power supply. One type is one or more replaceable battery which can be replaced within the handle, typically one or two AA or AAA cells. An example of such a toothbrush is the AQUAFRESH POWERCLEAN toothbrush. Such replaceable batteries may be non-rechargeable or re-chargeable. Some users of electric toothbrushes dislike the cost and inconvenience of replacing batteries. Moreover commonly used AA cells are quite heavy and bulky, thereby restricting the compactness of a handle containing AA cells.

A second type of power supply is one or more rechargeable battery within the handle which can be recharged by docking the toothbrush with a charging station which is connected with the electric mains. An example of such a toothbrush is the Dr BEST BRILLANT toothbrush.

It is also known to use a capacitor as an electric power supply for such a motor. DE – A-195 13 539 discloses a capacitor-powered toothbrush that comprises a charging station with inductive (non-contact) charging of a capacitor. The charging station is powered from the mains supply. JP-A-8088942 discloses a circuit of the same architecture as DE – A-195 13 539 with a mains powered charging station base unit and inductive charging. JP-A-2000245072 discloses a mains powered charging station base unit that appears to charge a capacitor in the charging station. The electrical energy is transferred from the capacitor in the charging station to another capacitor in the handle via electrical contacts, until the voltages on the capacitors are equal.

Toothbrush users normally clean their teeth in the bathroom (the term "bathroom" herein refers to any room where the user normally performs toothbrushing, regardless of whether it includes a bath), and there is a prejudice against using devices in the bathroom which need to be connected to the mains. Moreover many bathrooms are not provided with suitable mains sockets.

It is an object of this invention to provide an electric toothbrush with an improved electric power supply, providing inter alia greater convenience, and improved compactness and weight. Other advantages will be apparent from the following description.

Accordingly this invention provides:

an electrically powered toothbrush comprising a head which supports a bristle carrier, the head being connected to or connectable to a grip handle, the toothbrush incorporating an electric motor to move the bristle carrier to provide a cleaning effect, and incorporating an electric power supply which comprises a capacitor capable of containing sufficient electric charge to drive the motor for a tooth cleaning session,

in combination with a charging unit which incorporates an electricity supply and has an electrical connection means connectable to a corresponding connection means on the toothbrush to enable electrical connection between the capacitor and the charging station, and with which the toothbrush may be connected, and wherein the charging unit comprises means to apply a voltage V1 to the capacitor when the

toothbrush is connected to the unit, and means to temporarily apply a voltage V2 higher than V1 to the capacitor.

The invention is based on the finding that one or more modern commercially available capacitor can contain sufficient electric charge to drive the types of electric motor commonly used in electric toothbrushes for a useful period, and can directly replace one, two or more AA or AAA size battery for this purpose. In particular it is found that such capacitor(s) can rapidly be charged with sufficient electrical power for a toothbrushing session by connection with one or more replaceable or rechargeable battery cell, e.g. one, two or more AA or AAA size batteries in the charging station, without the need to connect the charging station to the electricity mains during the charging of the capacitor(s).

Generally the capacitor needs to provide electric power sufficient to drive the motor for at least one minute, preferably two minutes or more, for example up to three minutes or more, i.e. in line with dentists' recommendations for tooth brushing session times for adequate dental hygiene. Typically the rotary electric motors commonly used in electric toothbrushes have an 0.3W drive shaft power rating, with an estimated efficiency of 50%. Consequently the capacitor should be capable of delivering 0.6W electric power for this time period. Typically such motors can operate on a voltage supply of 1.5 – 3 volts, i.e. the typical output voltage of one or two (parallel or series connected) AA or AAA batteries, and the capacitor should be capable of delivering such an output voltage. It is found that a capacitor with a capacity of 15 - 50 Farad, preferably 16 – 22 Farad is capable of meeting these requirements, typically having a working output voltage of 1-5 - 3V, typically 2.5 +/- 0.25V.

Such capacitors are known, sometimes being termed in the art "Supercapacitors", "Ultracapacitors" or "Electrochemical double layer capacitors (EDLC)". They have ca. 2000x the volumetric capacitance of standard aluminium electrolytic capacitors. They combine the high energy density of batteries and the high power of capacitors. Such capacitors use high surface area carbon for accumulation of charge as opposed to the low surface area foils used in electrolytic capacitors. Suppliers include Panasonic, Elna, Epcos and Cooper Technologies. For

example Cooper Technologies' supercapacitors use aerogel carbon as the active material which offers high surface area and high electrical conductivity.

In addition to the ability to charge the capacitors from one or more batteries without a mains connection during the charging process, other benefits of use of such a capacitor for electric toothbrushes include the following.

They can be charged vary rapidly, e.g. in less than 1 minute, preferably less than 30 seconds, even less than 15 seconds, compared with the several minutes or hours required by ordinary rechargeable batteries. Typically supercapacitors can be charged for 1000+ charge cycles without detrimental effects or reduced life. Supercapacitors are also light weight (lighter than equivalent dry cells) and low volume. For example capacitors of various capacities have typical outside diameter and length dimensions as below:

| Capacitance (F) | Dimensions (mm) |
|---|---|
| 50 | 18 OD x 40 L |
| 33 | 33 OD x 35 L |
| 22 | 16 OD x 35 L |

Supercapacitors have an extremely low internal resistance for high power, low loss charging and discharging.

Moreover capacitors are environmentally friendly, containing no undesirable materials such as cadmium or zinc etc.

A particular advantage of a capacitor is that it need not be made in the typical cylindrical shape of a dry cell. The capacitor normally needs to be in the form of a closed loop, but this need not be cylindrical and so can be e.g. elliptical or "U" shaped in section, or a shorter fatter cylinder than the typical dry cell, or a hollow shell e.g. a tube within which other components of the electric toothbrush may be enclosed. This means that the capacitor can be adapted to the shape of the toothbrush handle rather than dictating the shape of the toothbrush handle.

Yet another advantage of the use of a capacitor as a source of electric power is that the toothbrush can be arranged to automatically stop when a suitable use time has elapsed, i.e. when the electric charge has been used up. This can act as a signal to the user that a suitable brushing time has elapsed, and can avoid the accidental battery run-down that may occur with a normal electric toothbrush using a dry cell

if it is left switched on. A typical toothbrush electric motor driven using one or more capacitor as above-described can for example run at a suitable brushing speed (as common in the art) for ca. two minutes then start to slow down, with a noticeable change in motor noise.

The capacitor may comprise a single capacitor e.g. of the capacity mentioned above, or two or more capacitors in a series or parallel connection to provide the above-mentioned electrical charge storage capacity.

By using such a capacitor an electric toothbrush can be made which is capable of being charged with sufficient electrical power to operate for one or more toothbrushing sessions by means of connection to a charging station incorporating typically 1 - 4 dry cells.

The capacitor of the toothbrushes of this invention may be conveniently initially charged and subsequently re-charged by connection with the charging unit with which it may be connected.

With this invention, when connected to the charging unit, the unit applies the voltage V1 to the capacitor, the voltage V1 being equal to or above the charging input voltage of the capacitor, so that the capacitor becomes and remains charged. Then shortly before the removing the toothbrush from the unit for use the charging voltage is temporarily increased to V2.

The benefit of temporarily increasing the charging voltage to V2 is as follows. By charging a capacitor with a higher input voltage than its specified normal charging voltage the charged capacitor can deliver more output power, or a required power for a longer period than if charged at a lower voltage, but if such a higher voltage is applied to the capacitor for a sustained period this can damage the capacitor. Therefore with the invention the capacitor can be charged and maintained charged by the lower charging voltage V1, and the higher boost voltage V2 may only be applied to the capacitor immediately before use to achieve the benefit of the higher voltage charging but with reduced risk of damage.

With the capacitors of the type discussed herein a suitable V1 is 2 - 3 volts, e.g. the nominal 2.4 volts delivered by two NiCd rechargeable cells connected in series, or the nominal 3 volts delivered by two typical AA or AAA replaceable cells in series. A suitable V2 is 3 - 4 volts e.g. the nominal 3.6 volts delivered by two

NiCd rechargeable cells connected in series, or the nominal 4.5 volts delivered by three typical AA or AAA replaceable cells in series. Such capacitors may have such a V1 applied to them constantly to maintain them charged, and may have such the voltage V2 applied for 10 seconds or less, e.g. 5 seconds or less immediately prior to use.

Suitably therefore the charging unit may incorporate a suitable number, e.g. 2 – 4 dry cells each of nominally 1.5V output, e.g. replaceable cells, such as AA or AAA batteries. The charging unit may be constructed to connect the capacitor to a first number of replaceable cells to apply V1, then to a second, larger, number of replaceable cells to apply V2. Typically such a charging unit may comprise a holder incorporating one or more, typically three, such dry cells. The charge characteristics of a capacitor depends upon the source impedance of the supply. Typically a capacitor as described above may be charged by application of a voltage V1 by connection to a voltage source of ca. 3.0 V, i.e. two typical dry cells in series. Replaceable alkaline disposable cells can charge a 22F capacitor in about 20 seconds by application of such a V1, and keeping such a voltage V1 applied to the capacitor can keep the capacitor charged. Shortly prior to use a voltage V2 may be applied by connection to a voltage source of ca. 4.5 V, i.e. three typical dry cells.

The charging unit may alternatively incorporate one or more rechargeable cell. Rechargeable NiCd cells are preferred in the charging station as they present the lowest source impedance, can be replaced or trickle charged from the mains supply, and can re-charge a 22F capacitor in about 10 seconds. The charging unit may be constructed to connect the capacitor to a first number of rechargeable cells to apply V1, then to a second, larger, number of rechargeable cells to apply V2. Suitably therefore the charging unit may incorporate a suitable number, e.g. 2 – 4 rechargeable NiCd cells, typically each of nominally 1.2 – 1.3 V output, and means to connect such battery(ies) to the electricity mains for charging in a generally known manner. Such a charging unit may for example have its battery(ies) charged by connection to a mains supply outside the bathroom, then be disconnected from the mains supply and transferred to the bathroom for use, to be re-charged when the charge in the battery(ies) is exhausted.

Typically each such rechargeable cell such as a NiCd cell is capable of delivering a voltage of nominally ca. 1.2 – 1.3 V. Therefore a capacitor as described above may be charged by application of a voltage V1 by connection to a voltage source of ca. 2.5 V, i.e. two typical rechargeable cells in series. Keeping such a voltage V1 applied to the capacitor can keep the capacitor charged. Shortly prior to use a voltage V2 may be applied by connection to a voltage source of ca. 3.6 V, i.e. three typical rechargeable cells.

The charging unit may be constructed so that sufficient such cells, e.g. two in series, are connected to the capacitor to apply a V1 of ca. 2.4 - 3.2V, and more e.g. these two plus a third, may then be connected via suitable switching to the capacitor to apply a V2 of ca. 3.6 - 4.8V. These delivery voltages are stated for new or fully charged cells.

The circuitry of the charging unit or toothbrush may include a resistor in series with the above-mentioned replaceable or rechargeable cells when they deliver V1 to reduce current and to charge the capacitor slowly.

Alternatively, to avoid the use of battery cells the use of which may in time fall foul of antipollution legislation such as the proposed EU WEEE Directive, the charging unit may be constructed to be connected to the electricity mains so as to derive charging and boost voltages V1 and V2 from the mains supply. Such a charging unit may comprise a suitable plug, connection lead, transformer, with switching and circuitry etc. to allow a suitable V1 and V2 to be applied.

Typically to enable the user to apply the voltage V2 for only a short time the charging unit may incorporate a biased switch which is operated by the user against the bias to apply the voltage V2, then when the user ceases to operate the switch the bias disconnects the voltage V2 and re-applies the voltage V1.

The toothbrush may include circuitry to slowly discharge the capacitor if it is left charged at V2 and not used, thereby reducing risk of damage to the capacitor. For example such circuitry may comprise a resistor to ensure slow discharge at low current and a diode e.g. a Zener diode so that discharge only occurs if the discharge voltage of the capacitor is above a set voltage e.g. the nominally 2.5V output voltage of the capacitor mentioned above.

In fact such a discharge circuit is believed to be novel per se when incorporated into an electric toothbrush powered by a capacitor. Therefore according to a further aspect of this invention an electrically powered toothbrush is provided comprising a head which supports a bristle carrier, the head being connected to or connectable to a grip handle, the toothbrush incorporating an electric motor to move the bristle carrier to provide a cleaning effect, and incorporating an electric power supply which comprises a capacitor capable of containing sufficient electric charge to drive the motor for a tooth cleaning session, which includes means to discharge the capacitor if it is charged above a defined voltage. Such circuitry preferably discharges the capacitor if it is left charged above its normal charging voltage and not used.

Suitably the toothbrush can be docked with the charging unit to achieve connection. Preferably the electrical connection means comprise low impedance contacts to deliver the high current charge pulse that occurs during the charging process, metal-to-metal contacts being suitable. For example the toothbrush may have electrical charging contacts on its outer surface which make contact with the connections when the toothbrush is docked with the unit. Preferably such electrical charging contacts on the toothbrush are shielded e.g. recessed to prevent accidental discharge of the charged capacitor.

The toothbrush may also incorporate means to disconnect one or more of the charging contacts from the capacitor when the toothbrush is removed from the charging unit for use. For example such means may comprise a reed switch biased into a state in which a contact is disconnected from the capacitor, and a magnet incorporated into the charging unit to urge the reed switch into a state in which the contact is connected from the capacitor when the toothbrush is connected to the unit.

In fact such means is believed to be novel per se when incorporated into an electric toothbrush having charging contacts. Therefore according to a further aspect of this invention an electrically powered toothbrush is provided comprising a head which supports a bristle carrier, the head being connected to or connectable to a grip handle, the toothbrush incorporating an electric motor to move the bristle carrier to provide a cleaning effect, and incorporating an electric power supply, having charging contacts to facilitate connection of the power supply to a charging unit, and

incorporating means to disconnect one or more of the charging contacts from the power supply when the toothbrush is removed from the charging unit.

A charging unit, provided for a toothbrush as described above, comprises a further aspect of this invention.

The head, bristle carrier, overall construction of the handle, motor, controls e.g. on-off switch etc. of the toothbrush and its grip handle may be otherwise conventional.

Some suitable electric toothbrush motors are listed below:

| Manufacturer | Motor | Size (mm) | Reduction Gear ratio | Speed (rpm) | Efficiency (%) |
|---|---|---|---|---|---|
| Johnson | Standard | 20 x 32 | 1:1 | 3500 | 60 |
| Mabuchi | FF-M20VA | 10 x 16.7 | 3:1 | 3000 | 42 |
| Mabuchi | RF-M20VA | 10.1 x 27 | 4:1 | 3500 | 55 |
| Sanyo | TG-1001 | 10 x 17 | 3:1 | 3500 | 50 |
| Sanyo | TG-1201 | 12 x 16 | 3:1 | 3500 | 60 |
| Sanyo | 10L-M-03-150 | 10 x 25 | 4:1 | 3500 | 53 |
| Namiki | SLC10-1806 | 10 x 18.1 | 2:1 | 3500 | 50 |

Typically a rotary or oscillatory rotary motion toothbrush head experiences a load of 200-700 g during use, and it is found that the rotary motors listed may be driven using the capacitor electric power supply or rechargeable electricity storage means of the invention, the Sanyo TG-1001 being a particularly low cost compact motor capable of powering a typical electric toothbrush drive train. Commercially available gearboxes are available e.g. Maxon™ which are suitable for use with such motors to for example provide the 4:1 reduction.

It has been found that the capacitor can be connected directly to the electric motor in a simple replacement for the one or more AA or AAA battery with which the electric toothbrush is normally provided for use. However for some applications it may be advantageous to use known power management circuitry, e.g. pulse-width modulation circuitry. Such circuitry may for example be provided on a "chip" to control the power flow from the capacitor to the motor, e.g. a voltage regulator or current limiter to maintain constant speed as the capacitor discharges. Suitable circuitry is apparent to those skilled in the art, or for example as disclosed in DE –

A-195 13 539, JP-A-8088942 and JP-A-2000245072 above-mentioned. However it has been found that the toothbrush can function effectively without such circuitry when capacitors of the above-described type are used, e.g. with the capacitor connected directly to the motor with optionally only an on-off switch or circuit breaker between the capacitor and the motor.

Using capacitors of the above described types the toothbrush may be recharged from ca. three replaceable or rechargeable (e.g. NiCd) dry cells in ca. 10-20 seconds with sufficient electrical power for at least one toothbrushing session, in some cases e.g. with optimised efficient motors, drive train etc, for two or more toothbrushing sessions.

Preferably the capacitor has a capacity of 16 – 22 Farad. Typically the capacitor has a working output voltage of 1-5 - 3V, typically 2.5 +/- 0.25V. The toothbrush may incorporate two or more capacitors in a series or parallel connection to the motor to provide the mentioned electrical storage capacity.

The invention will now be described by way of example only with reference to the accompanying drawings.

Fig. 1 shows the characteristics of a motor driven by a capacitor.

Fig. 2 shows schematically the electric circuitry of an electric toothbrush of this invention.

Referring to Fig. 1 this shows the run down characteristics of an electric toothbrush head driven by a capacitor. A Sanyo "micromotor" TG 1001 was linked to a Maxon 4:1 reduction gearbox and the output shaft of this gearbox was connected directly to the drive shaft of a commercially available replaceable reciprocally-rotary brush head of a commercially available "AQUAFRESH"™ electric toothbrush. The motor was connected directly to a 20F supercapacitor. The three graphs show the run down characteristics following initial charging of the capacitor at 3.6V and running the motor both unloaded and with a 200g load on the brush head, and initially charging the capacitor at 3.0V then running it with a 200g load. It is seen that charging at 3.6V enables the motor to run the rotary brush head at a speed above a target 3500 rpm for a longer time than if the capacitor is charged at 3.0V. Loading is defined as pressing the bristle tips of the head against a surface at a pressure of 200g.

Referring to Fig. 2 the circuitry of a toothbrush 10 overall is shown schematically. A Sanyo TG-1001 electric motor 11 is linked by a 4:1 Maxon reduction gearbox 12 to a commercial Aquafresh replacement electric toothbrush head 13. The motor 11 is connected via a manual on-off switch 14 and two-way reed switch 15 to a Cooper 20F capacitor 16. One terminal 17 of capacitor 16 is connected to charging contact 18. The other terminal 19 is connected via reed switch 15 to charging contact 110. The reed switch 15 is normally biased into the full line position to connect the capacitor 16 via switch 14 to motor 11.

The circuitry of a charging unit 20 overall is also shown. Unit 20 contains three rechargeable NiCd cells 21,22,23 each with an output voltage of typically 1.2V when fully and freshly charged. Two of these cells 21, 22 connected in series are connected via biased two-way switch 24 to charging contacts 25, 26. Switch 24 is biased so that two of the cells 21,22 are normally connected to contacts 25,26 so as to apply a V1 of ca. 2.4V to contacts 25,26. Switch 24 can be operated by a user e.g. by a push button (not shown) to put it into the dotted line position temporarily to connect all three cells 21,22,23 to contacts 25,26 to apply V2 of 3.6V to the contacts 25,26. With this arrangement the toothbrush 10 may be connected to charging unit 20, thereby connecting contacts 18,110 and 25,26. A magnet 28 is located in the charging unit 20 and when the toothbrush 10 is connected to unit 20, e.g. by the toothbrush being brought into close proximity with the unit 20 e.g. into a socket mounting in unit 20 magnet 28 urges reed switch 15 into the dotted line configuration to connect contacts 18,110 to capacitor 16 and to thereby connect capacitor 16 to cells 21,22 via contacts 25, 26.

The capacitor 16 is thereby charged and maintained charged whilst it remains connected to unit 20. Immediately prior to use switch 24 is operated by the user for e.g. five seconds against its bias to apply ca. 3.6V to capacitor 16. After this the user may release pressure on the operating button (not shown) to return switch 24 to its normal closed line biased position. The toothbrush 10 can then be disconnected from unit 20. This action removes magnet 28 from close proximity to reed switch 15 so that switch 9 moves into its biased dotted line position to connect capacitor 16 to motor 11 via on-off switch 14. Closing on-off switch 14 connects the capacitor 16 to motor 11 to operate toothbrush head 13.

Other features of the circuitry are shown. A resistor 29 limits the current flow from cells 21,22 to capacitor 16 so that cells 21,22 charge capacitor 16 slowly, and diode 210 protects against backflow of current. A "capacitor charged"/"battery health" indicator is provided at 211, and comprises a Zener diode with a nominal 3.5V rating, an LED and a ballast resistor to prevent overcurrent of the LED. When in boost mode, i.e. with the higher voltage being applied to the capacitor 16 the voltage will dip as the capacitor 16 is charged. As the voltage climbs to 3.5V and the brush is ready for use the Zener diode will allow current to flow and light the LED to indicate readiness for use. Feature 212 is a resistor in series with a zener diode set to slowly discharge capacitor 16 if it is charged with a voltage above ca. 3V. Feature 212 causes capacitor 16 to discharge if it is charged at above 3V by connection to cells 21,22,23 and left in this charged state without being used as described above.

Although illustrated using cells 21,22,23 to apply voltages V1 and V2 via suitable switching it will be apparent to those skilled in the art how the unit 20 may alternatively be constructed such that unit 20 may be connected to the electricity mains supply and V1 and V2 generated using e.g. a transformer and suitable switching.

It will also be apparent to those skilled in the art how unit 20 as illustrated could also be provided with means to charge cells 21,22,23 from the electricity mains.

Resistors 29, 211 and 212 referred to herein have a nominal resistance of 100 ohm but could be in the range 20 – 1000 ohm.

**Claims.**

1. An electrically powered toothbrush comprising a head which supports a bristle carrier, the head being connected to or connectable to a grip handle, the toothbrush incorporating an electric motor to move the bristle carrier to provide a cleaning effect, and incorporating an electric power supply which comprises a capacitor capable of containing sufficient electric charge to drive the motor for a tooth cleaning session,

in combination with a charging unit which incorporates an electricity supply and has an electrical connection means connectable to a corresponding connection means on the toothbrush to enable electrical connection between the capacitor and the charging station, and with which the toothbrush may be connected, and wherein the charging unit comprises means to apply a voltage V1 to the capacitor when the toothbrush is connected to the unit, and means to temporarily apply a voltage V2 higher than V1 to the capacitor.

2. A combination according to claim 1 wherein the capacitor is capable of delivering 0.6W electric power for 2 minutes or more.

3. A combination according to claim 1 or 2 wherein the capacitor has a capacity of 15 - 50 Farad and a working output voltage of 1-5 - 3V.

4. A combination according to any one of claims 1 to 3 wherein the capacitor is an electrochemical double layer capacitor.

5. A combination according to any one of claims 1 to 4 wherein voltage V1 is equal to or above the charging input voltage of the capacitor.

6. A combination according to any one of claims 1 to 5 wherein the invention the capacitor can be charged and maintained charged by the voltage V1.

7. A combination according to any one of the preceding claims wherein V1 is 2 - 3 volts.

8. A combination according to any one of the preceding claims wherein V2 is 3 - 4 volts.

9. A combination according to any one of the preceding claims adapted that voltage V2 may be applied for 10 seconds or less.

10. A combination according to any one of the preceding claims wherein the charging unit is constructed to connect the capacitor to a first number of replaceable cells to apply V1, then to a second, larger, number of replaceable cells to apply V2.

11. A combination according to any one of claims 1 to 9 wherein the charging unit is constructed to connect the capacitor to a first number of rechargeable cells to apply V1, then to a second, larger, number of rechargeable to apply V2.

12. A combination according to claim 10 or 11 wherein the circuitry of the charging unit or toothbrush includes a resistor in series with the replaceable or rechargeable cells when they deliver V1.

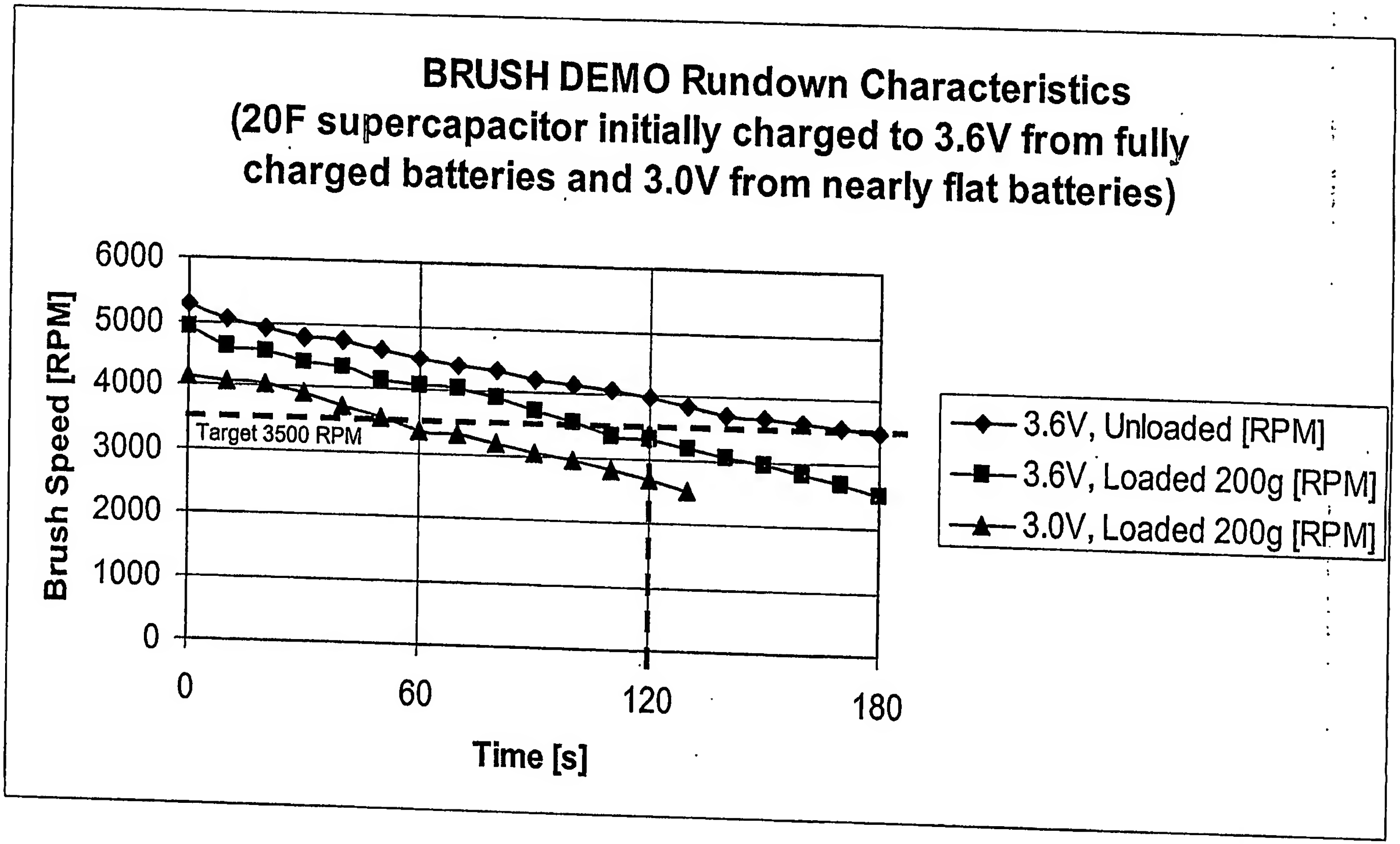
13. A combination according to any one of claims 1 to 9 wherein the charging unit is constructed to be connected to the electricity mains so as to derive charging and boost voltages V1 and V2 from the mains supply.

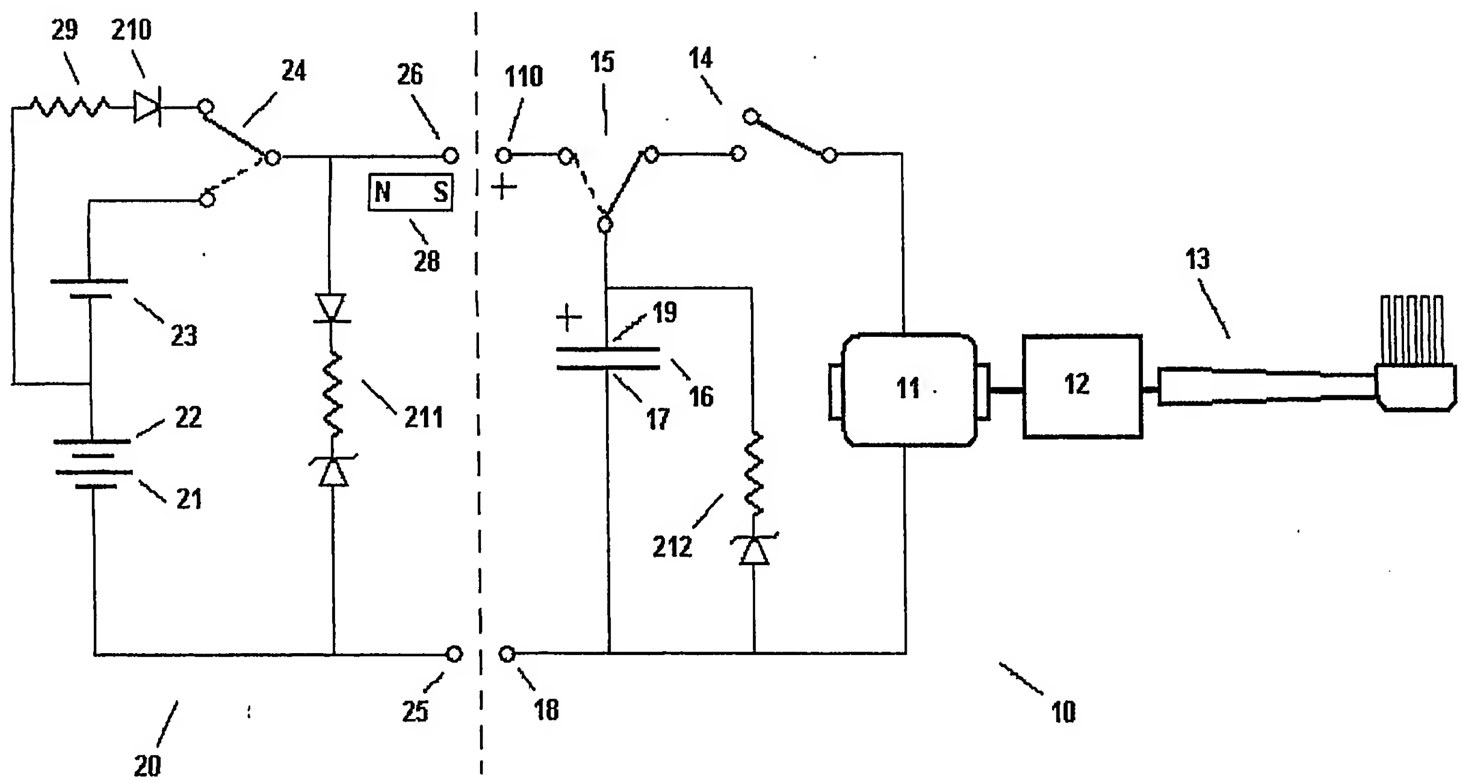
14. A combination according to any one of the preceding claims wherein the charging unit incorporates a biased switch which is operated by the user against the bias to apply the voltage V2, then when the user ceases to operate the switch the bias disconnects the voltage V2.

15. A combination according to any one of the preceding claims wherein the toothbrush includes circuitry to discharge the capacitor if it is left charged at V2 and not used.

16. A combination according to any one of the preceding claims wherein the toothbrush incorporates means to disconnect one or more of the charging contacts from the capacitor when the toothbrush is removed from the charging unit for use.

Fig. 1


BRUSH DEMO Rundown Characteristics
(20F supercapacitor initially charged to 3.6V from fully charged batteries and 3.0V from nearly flat batteries)
Brush Speed [RPM]
6000
5000
4000
3000
2000
1000
0
Target 3500 RPM
0
60
120
180
Time [s]
3.6V, Unloaded [RPM]
3.6V, Loaded 200g [RPM]
3.0V, Loaded 200g [RPM]



29
210
24
26
110
15
14
N S
28
23
22
21
211
+
19
16
17
212
11
12
13
25
18
10
20


FIG. 2